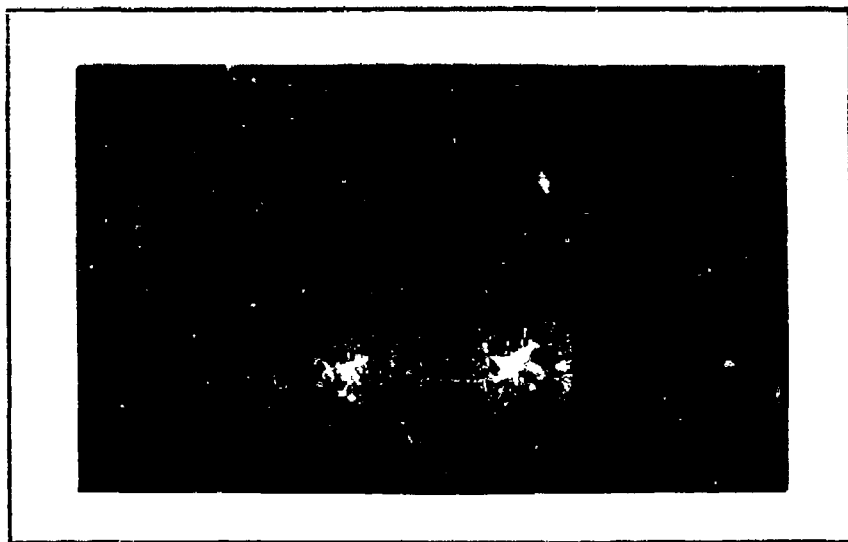# Carnegie-Mellon University
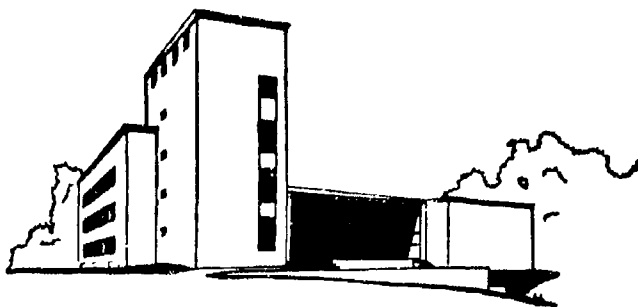
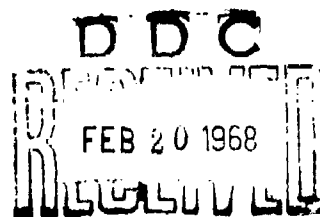**PITTSBURGH, PENNSYLVANIA 15213**

GRADUATE SCHOOL OF INDUSTRIAL ADMINISTRATION

WILLIAM LARIMER MELLON, FOUNDER

"The Strategic Dimension of
Computer Systems Planning."*

by

Charles H. Kriebel

January, 1968

The past two decades have seen the birth of an information processing revolution of far greater significance to corporate top management than the famous industrial revolution of the last century. The "machine of today" is the computer, a capital resource which has the power to augment management's mental as well as physical capabilities.

I. The Computer Challenge Today

The computer has long since outgrown its image as a large desk calculator or a fast accounting machine. A recent report by the American Federation of Information Processing Societies[1] projects that the number of computers installed in the world will increase from 39,000 in 1967 to about 85,000 in 1975. The cumulative value of installed equipment in 1965 was $7.5 billion in the United States and $3 billion for all other countries; these figures, respectively, are estimated to increase to $31.5 billion and $9.4 billion by 1975. Why today, as never before, has the computer issue become critical? Why do today's decisions on computer systems require the attention of corporate top management?

1. The Computer is a Key Economic and Competitive Resource

The company computer system is a strategic economic resource of the corporation, as much as a company's capacity for production, its marketing position, or its financial reserves. Today, computer system resources are strategic because they influence the relationship between the firm and its environment; they affect and have the power to augment all other capital resources of th ompany. Computer systems influence the internal operating

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[1] An AFIPS Report: The State of the Information Processing Industry, American Federation of Information Processing Societies, 211 East 43d Street, New York N.Y. 10017 (April 1966).

efficiency of the company by increasing the utilization and productivity of other resources. They also affect critical nonfinancial factors of the company, such as through improved order processing and customer service. More importantly, however, computer systems affect the external competitive strength of the company. The relative quality of a company's computer system will be reflected directly in its ability (or inability) to protect its market position, to provide reliable commitments to customers, to develop new process technology, and so on. Five years ago when American Airlines undertook development of its SABRE system, a computer-based complex for processing customer ticket reservations, company management recognized that such a system would critically influence their competitive position in the industry.[2] Competition could not long afford to permit the SABRE system to remain unchallenged, once its impact had been felt in the market place. In this context, computer systems affect the future growth and stability of the company and can influence a company's product-market scope to an extent comparable with research and development efforts.[3]

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[2] For example, see G. Burck and the Editors of _Fortune_, _The Computer Age_ (Harper Torchbooks, Harper and Row Inc., New York, 1965).

[3] For example see H. I. Ansoff, _Corporate Strategy_ (McGraw-Hill Book Company, New York, 1965) for a discussion of R & D and the corporate product-market scope.

2. Computer Systems Today Affect the Entire Organization

The company computer system of today is no longer a "data processing service group" -- for engineering or accounting -- with crisp organizational boundaries; it has become an amorphous activity which crosses traditional lines of authority and goes beyond any organization sub-group. Consider the fully integrated company in a basic industry, which traditionally has maintained a highly centralized organization under two primary functions: marketing and manufacturing. The development of a computer based, corporate-wide information system can readily lead to a fundamental reorganization of the company with full decentralization by profit centers. Similarly, computers today are affecting the management process of the company itself and are changing the types of interpersonal relations whi·h have existed in the past. Where is the "line and staff" in an automate: factory? Is the man operating the "pushbutton" in a computerized refinery, line management or staff? The concepts of "line and staff" are fast losing their traditional meanings in the computer age of today. The computer <u>as staff</u> has become the strongest support arm top management has ever had.

3. The Pace of Computer Technology is Accelerating

Dynamic changes in computer technology have increased the time horizon for computer system planning to the point where it is approaching the horizon of other key decision areas of top management. The projected 400 to 500 percent growth in computer installations over the next seven years is only part of the story. For example, there has been an increase of over 100 percent in "computing

power"(the number of caluclations a computer can perform in one minute for a
fixed dollar cost) every two years since 1960.[4] Said differently, a $1 million
computer of today is four times faster than (or handles four times the workload
of) a $1 million computer of 1960. Thus, to obtain an accurate picture of the
impact of the computer "revolution," the annual increase in the number of com-
puter installations outstanding must be adjusted upwards to reflect the
additional power available per computer installed. Furthermore, new computer
technology has come into existence which has significantly affected the scope
and direction of future planning. For example, computer time sharing which
permits economically the direct access to computer systems from geographically
remote locations and computer graphics or graphical display devices, provide
management opportunities for computer applications today which weren't possible
ten years ago. [5]

It has been argued that the absolute size of the investment in physical
computer resources today is still small in comparison with other key decision
areas of top management. For example, McGovern[6] reports that in 1965 the
value of computers installed at General Motors was $174.61 million in contrast
with $20.7 billion sales and $12.6 billion assets; the largest foreign company
investment in computers was $67.12 million at Royal Dutch Shell whose 1965
sales and assets were $7.18 billion and $2.67 billion, respectively.

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[4] AFIPS, loc. cit.

[5] See G. Burk, loc. cit. and also J. Main, "Computer Time-Sharing -- Everyman
at the Console" Fortune, Vol. 76, No. 2 (August 1967), p. 88-91 ff.

[6] P. J. McGovern, "Exclusive Report -- The EDP 100," EDP Industry and Market
Report, Vol. 2, No. 18 (February 10, 1967), International Data Publishing Co.,
P. C. Box 1, Newtonville, Mass., 02160.

However, the scale and scope of other company resources affected by computer
decisions considerably magnifies the importance of the dollar investment in
computer equipment. In particular, the key investment in computer systems is
people and experience, not dollars. A typical computer system application
can involve twenty man-years of technical effort and several additional years
educating management personnel before the system is implemented. Today,
computer-skilled personnel and computer-oriented management personnel are in
short supply and high demand. This shortage of personnel resources will become
a problem of increasing severity in the future.[7]

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[7] AFIPS, loc. cit.

11. Management and the Computer: Facts and Folklore

Effective utilization and exploitation of the computer's potential by
industry demands that all levels of management participate in and contribute
to the development of corporate computer systems. Beyond the obvious, however,
advice on management's role in the computer age has varied considerably and is
often contradictory or unnecessarily vague. In particular, top management is
fast becoming the orphan of the computer revolution. What is top management's
responsibility for corporate computer systems planning? To provide the answer
to this question it is important to first put the computer-management issue in
perspective: to establish some of the facts and to dismiss some of the folk-
lore which the experience of the last decade has shown.

1. "Management is losing its place to the computer."

Ten years ago Professors Leavitt and Whisler[8] attempted to predict the
course of management in the 1980's. One noteworthy prediction of theirs was
the declining role of middle management in the firm of the future. Leavitt and
Whisler envisioned increasing automation of middle management decision functions
and, eventually, the usurpation of middle management positions by decision-
making programs in computer systems. From the facts to date, this prediction
is likely to become folklore over the next generation. There is no question
that decision functions have and will continue to become automated as computer
system development expands. Similarly, there is no question that computer
systems have affected and will continue to affect management processes and
the corporate organization structure. However, instead of being replaced by the
computer, middle management has flourished -- thanks in part to the computer

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[8] H. J. Leavitt and T. L. Whisler, "Management in the 1980's," Harvard Business
Review, Vol. 36, No. 6 (November-December, 1958), p. 41-48.

itself. As company computer systems have grown they have indeed automated many routine decision and data processing functions. But simultaneously, middle management functions have expanded, taking on increased responsibilities as computer systems have permitted the more effective allocation of time, skills, and resources. It would be naive at best to say that managers thirty years hence will be functioning in organizations in the identical roles they occupy today. High school students today know more about the physical sciences than the eminent scholars of the last century. Management problems today differ markedly from management problems of the 1930's or the 1920's -- the economic, political, and social world of today is not the world of thirty years ago. There is considerable evidence to indicate that change over the next three decades will continue to accelerate, that new management problems will arise and that computer systems will present expanding challenges for exploitation by society.[9] This is _not_ to say that tomorrow's manager will be replaced by an electronic calculating machine. Today, the computer is recognized not as a threat to middle management security, but rather as a potentially valuable partner to managerial progress.

2.   "Computers can only do what they have been told to do."

Herbert A. Simon recently remarked, "The fact that computers can only do what they are programmed to do -- is intuitively obvious, indubitably true, and supports none of the implications that are commonly drawn from it."[10]

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[9] For example, H. A. Simon, "The Corporation: Will It Be managed by Machines?", p. 17-56 in M. Anshen and G. L. Bach (ed), _Management and Corporations 1985_ (McGraw-Hill Book Co., New York, 1960), and D. F. Parkhill, _The Challenge of the Computer Utility_ (Addison-Wesley Publishing Co., Reading, Mass., 1966).

[10] H. A. Simon, _The Shape of Automation_ (Harper and Row, Inc., New York, 1965).

Practically speaking, industry today has only begun to tap the powerful potential of the computer. For example, many U. S. Firms still evaluate computer system development proposals on the basis of a single criterion: clerical cost reduction. The computer's ability to yield significant cost savings through the mechanization of data processing activity is well known. However, a computer system which, for example, links together petroleum refinery scheduling and control with profitability accounting, can provide second and third order economic effects far in excess of first order efficiencies. The potential of computer systems to improve the management process itself, which in turn influences the physical environment, can substantially multiply the computer's payoff. If an expert writes a computer program that permits a computer to play the game of chess, and subsequently, the computer (program) beats the expert and all other opponents, has the system exceeded the capability of its creator? There is no question that computer systems have a vast potential for synergism.

3. "Excellence in data processing is essential for good management information"

This fact is usually recognized in principle, but too often misinterpreted in the practice of planning management information systems development. Management information is data which supports and is relevant to the execution of managerial decision and control functions. Without good data processing it is impossible to have good management information. It does not follow, however, that given good data processing good management information will necessarily result. Any manager who has been buried in the pages of a computer output report will readily attest to the computer's capacity for printing, and simultaneously curse its inability to distinguish importance from details. The fact that good data processing is a necessary condition for good management

information, often misleads management into accepting the following fallacy:

4. "Company computer planning is best left to the technicians."

Confusion in understanding has contributed to the rise of a "computer mystic" in the minds of the management of many companies. Managers all too willingly decry: "I'm no computer 'expert' and am too busy to become one. Sure we have a computer, and we have experts to run it. I run the company's business and they run the computer's business." The truth that unfortunately has been missed in this case is that the "computer's business" should be the "company's business". To begin with, the computer is a disarmingly simple machine; in fact, its mode of operation is simpler than that of a washing machine or the automobile.[11] Because the computer is electronic it can perform millions of

very simple operations at incredible speed. When we incorporate this capability into a hierarchical (or building-block) structure where each level mirrors the structure of adjacent levels (as do the layers of skin in an onion), the computer becomes complex -- but not mystical. The technical details of computer technology, as such, are best left to computer technicians--managers should not seek to become "computer experts". The economic payoff from the computer lies not in its technical prowess, per se, but rather in how this power is used in the firm. Computer planning and resource allocation must become the concern of management to ensure that these resources are used well.

Considerable evidence has shown that in all cases where management has not taken an active role in computer systems development the system has been an

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[11] For example, see R. Campbell, "How the Computer Gets the Answer," Life (October 27, 1967), p. 61-72.

economic disappointment. For example, in 1963 John Garrity[12] found that there
was unusually high correlation in companies between the successful utilization
of the computer and the degree of management's involvement in its planning and
implementation. Success in this case was measured in terms of both cost savings
and intangible benefits, such as more accurate and timely information. Only line
management's knowledge of corporate economics can ensure that computer resources
will be employed in key areas of the business. Furthermore, only top management
is in a position to assess the long term, strategic direction of the company
and consequently the role of computer resources in planning corporate growth.
A wait-and-see attitude or a company policy of non-involvement with computers
by an indifferent management may well mean economic disaster for that company
in the future.

III. Top Management's Role

The intuitive or ad hoc approach to computer development planning doesn't
work; maximum payoff from computer systems demands top management's direction
and support. Computers require "building things in place," there are a lot
of options in planning systems development, and the impact of today's commit-
ments carries substantially into the future. Because of the importance, scope
and organizational impact of computers today, the management philosophy of the
company is intimately involved. Computer efforts will fail if top management
philosophy isn't recognized and stated explicitly or if the computer is used
primarily as a vehicle to force changes in philosophy.

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[12] J. T. Garrity, "Top Management and Computer Profits", Harvard Business Review
Vol. 41, No. 4 (July-August, 1963), p. 6-12.

1. The Company Computer Strategy

Optimizing computer development and payoff for the firm is basically a two-phase decision process: first, the chief executive officer and top management establish a computer strategy for the company; second, the computer executive and line management develop a computer systems plan to implement the stated strategy for the company.

A company computer strategy defines the computer's role in attaining strategic objectives of the corporation. Following Ansoff[13], "strategic" objectives are those which pertain to the relation between the firm and its environment; "non-strategic" objectives concern the internal workings of the company, i.e., so-called administrative and operating decision problems. Strategic planning of the computer systems development is decision-making: deciding what to do, how to do it, and at what speed and cost to do it. The strategic issue is not past success or failure with computer systems, but rather how the company looks at this effort today and tomorrow. A company's computer strategy provides the framework to answer two fundamental questions:

How much of this resource should we have now and in the future?

How do we manage our computer effort optimally in the face of competition?

Top management's role in the strategic planning of computer resources development is illustrated in the flowchart of Figure 1. After Donald J. Smalter[14] and others, we distinguish corporate objectives from goals as the broad and usually unbounded statements of long range corporate ends that are

[13] H. I. Ansoff, loc. cit.

[14] D. Smalter and L. Ruggles, Jr., "Six Business Lessons From the Pentagon," Harvard Business Review, Vol. 44, No. 2 (March-April 1966), p. 64-75; also E. Gilmore and R. G. Brandenburg, "Anatomy of Corporate Planning," Harvard Business Review, Vol. 40, No. 6 (November-December 1962), p. 61-69.

Figure 1

COMPUTER RESOURCES DEVELOPMENT IN STRATEGIC PLANNING
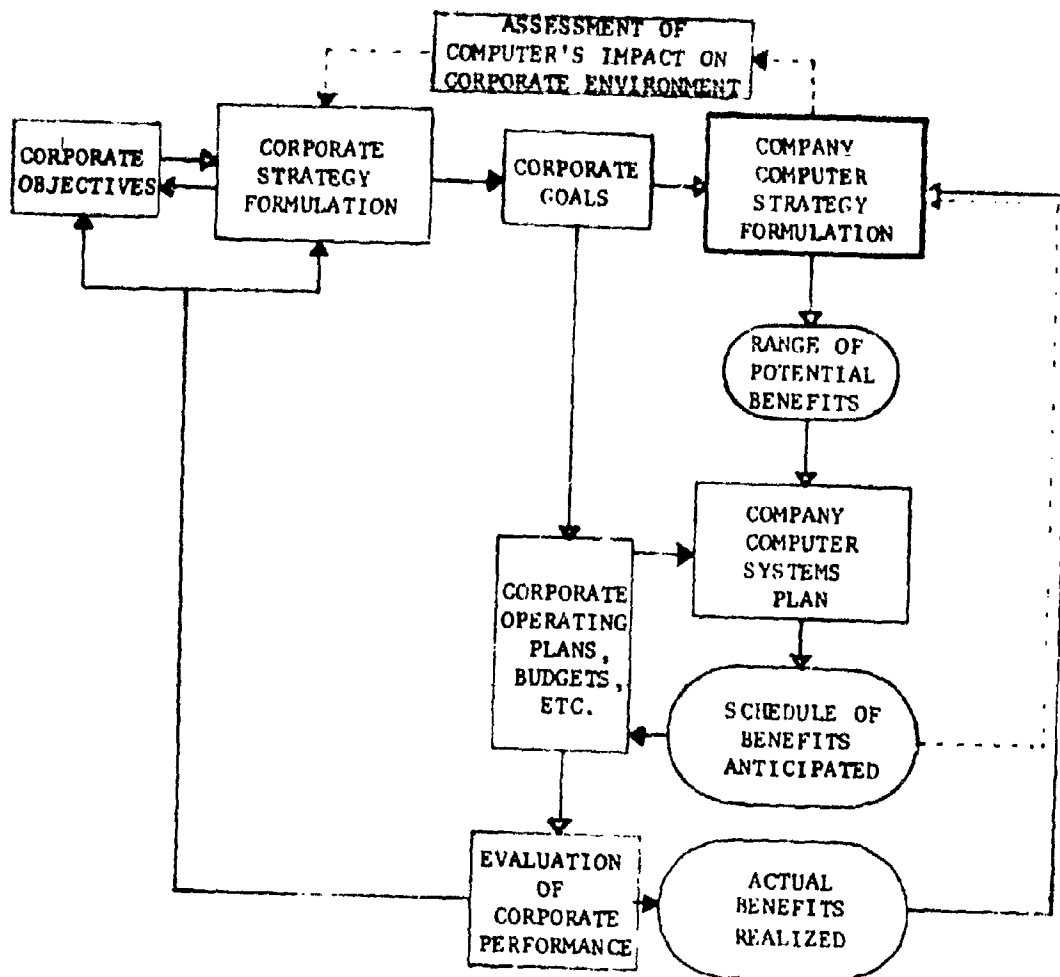
not limited by quantitative or time requirements, whereas corporate goals are
definitive and quantitative statements pertaining to target events or milestones
which are ranked and time-phased in terms of the objectives. The process of
formulating a corporate strategy provides an output ranking of corporate goals
for the company. These goals provide the basis for establishing corporate
operating plans and for deriving goals for computer systems development. The
company computer strategy specifies a range of potential benefits for the
detailed operating and technical planning of computer systems. The computer
strategy establishes policy, resource and time constraints, and the performance
criteria for evaluating computer plans. The computer systems plan is formulated
by the computer executive in conjunction with top management, other corporate
operating plans, and line management. The computer plan provides a schedule of
anticipated benefits within the range and reference environment established by
top management. The actual benefits realized provide feedback for updating the
company computer strategy in light of results. In addition, the computer
strategy provides a reference for assessing the impact of computer technology
on the total corporate environment -- such as, in evaluating the impact of this
technology on the product-market scope of the company. Thus, computer system
objectives which are derived from corporate goals can, in turn, influence
corporate strategy establishing new corporate goals, and so on.

2. Computer Strategy Formulation

There exists explicitly or implicitly a computer strategy in every company.
Even the absence of a formal computer strategy (and/or computer plan) is
implicitly a policy to ignore the computer as a vital resource of the company.
The process of formulating a company computer strategy involves three basic

stages of decision making by top management:

(1) the derivation and statement of explicit objectives for the

development of company computer resources and the specification of

performance criteria for evaluating computer systems efforts;

(2) policy decisions which establish the corporate environment for

computer development -- in particular, the time horizon for planning

and growth, the commitment of financial and personnel resources, and

the management organization structure for computer systems effort;

(3) an appraisal of the company's current position in computer systems

development, i.e., where it stands today in terms of competitive

advantages and competitive limitations.

A decision flowchart of these three basic stages in computer strategy formulation
is illustrated in Figure. _.

Strategic objectives for computer resources development are derived from
corporate objectives and goals which pertain to the relation between the firm
and its environment. Only top management is in a position to accurately
identify the key strategic issues which ultimately determine corporate success --
profitability and growth -- in the face of competition. Objectives for
computer system plans become meaningful only if they bear directly on overall
corporate goals. Clearly, the strategic goals of the corporation will depend
upon the particular company, its industry position, technology, and the
environment. Similarly, the order of magnitude of the computer systems effort
and it potential impact should guide the chief executive's degree of involve-
ment. That is, the opportunities and means for gaining economic leverage from
the computer differ across companies and consequently goals and plans for

Figure 2

A   DECISION   FLOWCHART   FOR   COMPUTER STRATEGY   FORMULATION
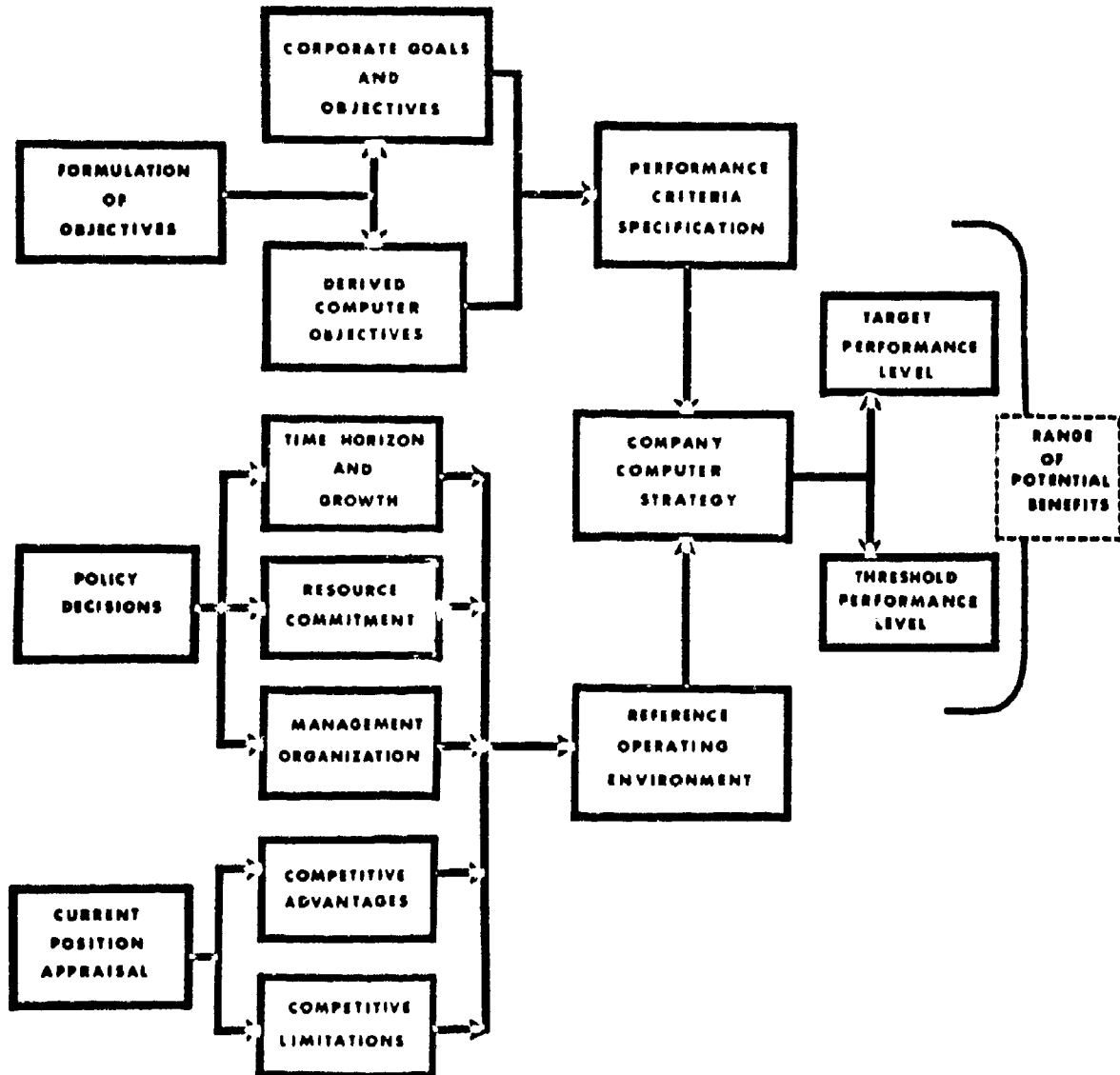
computer systems must be specific to the individual firm. Some examples should serve to make these points explicit.

3. Computer Strategy Examples.

Consider a manufacturer in the consumer-products industry, such as soap or cosmetics, who has adopted a corporate marketing strategy of product innovation -- that is, the introduction into the market of new products or new variations of existing products ahead of competition. Suppose the firm has decided that a corporate goal with respect to marketing is to release at least one "major innovation" in each of its product lines every two years. How might the computer serve as an enabling device in this case? Top management might establish a computer strategy objective to perfect decision analysis capability within corporate computer systems. This decision analysis capability might take the form of venture decision models, computer simulations, programs to analyze empirical marketing data, optimization routines, or similar activity. The development, planning details, and action programs for specific alternatives would emerge within the company computer system plan, given the strategic objective ("expand decision analysis capability") and a strategy for computer systems operations established by top management. An example profile of one such strategy in this case is diagrammed in Figure 3. Figure 3 also illustrates the types of questions which must be answered at each stage in the process of formulating a computer strategy. The specification of a computer strategy provides a set of decision rules which direct and bound the search among alternative computer system plans and ultimately ration computer resources in the best interests of the corporation. The degree to which these decision rules will be more or less specific will depend upon the level of detail which top

Figure 3

EXAMPLE PROFILE OF A COMPANY COMPUTER STRATEGY
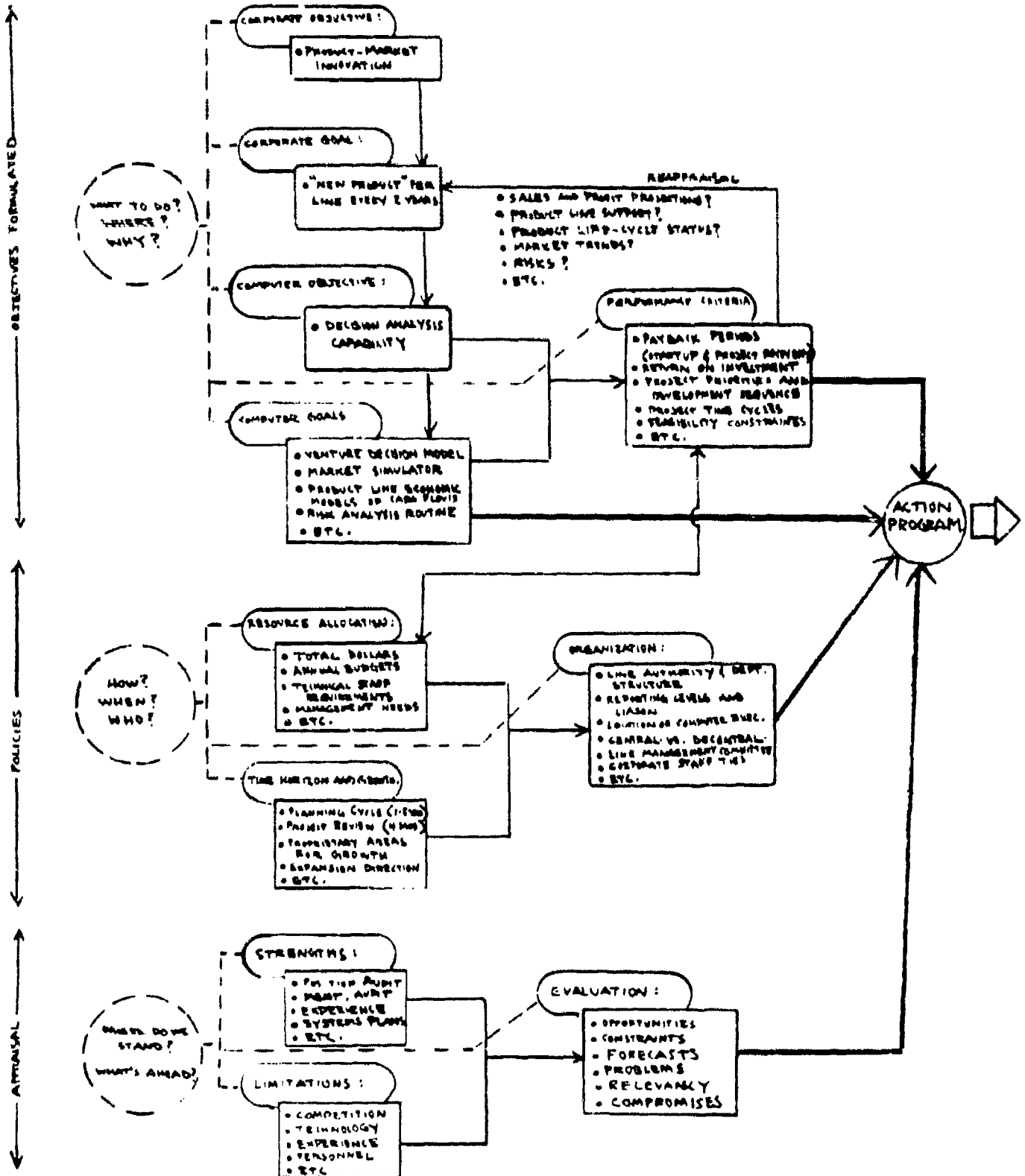
management provides in answering the relevant questions. This is not to imply
that top management should become expert in the detail necessary to implement
action programs for computer systems, no more so than this requirement exists
in research and development activity. The decisions required of top management
are key management decisions which reflect corporate strategy and corporate
economics, as well as the background of top corporate executives. The computer
executive, as the research and development executive, provides the requisite
liason for top management between strategic goals and the technology.

As another example, consider a merchandising firm, such as a retail store
chain for low cost household items, that adopts a corporate marketing strategy
based on price competition. For instance, suppose the company has established
a corporate marketing goal to lead with the lowest price on items or to always
meet a competitor's lower price. In this case, top management might decide on
a computer strategy objective to establish online communication and data
processing capability within corporate computer systems. For example, the
capability for instantaneous and direct communication of computer data between
all retail stores becomes the operating objective of the company computer plan.
The existence of online data processing capability between all company locations
could well provide the basis for a more aggressive or expanded marketing campaign
with respect to industry competition. As in our previous example, given the
objective, formulation of the particular computer strategy would then proceed
to establish goals, performance criteria, and policies to provide the basis
for developing specific computer system plans and action programs.

As a third example of computer strategy objectives in context, consider two
firms: one a manufacturer in the process industries, the other a highly
diversified corporation which was formed from a conglomerate of companies in

different industries. Suppose the manufacturer has adopted a corporate growth strategy of increased vertical integration and internal expansion. Suppose, on the other hand, the conglomerate corporation has adopted a corporate growth strategy of increased diversification through acquisition. The top management in both of these companies might adopt the same computer strategy objective to increase the integration of corporate management information systems and computer efforts, for different reasons. The manufacturer may envision increased integration between his process control and management systems as a means for improving the planning, control, and direction of expansion within the company. In this regard, the marriage of engineering instrumentation and managerial economics can highlight cost bottlenecks and the impact on profits of increasing control and capacity. The conglomerate corporation may envision the integration of company information systems as a means to developing a corporate-wide management information file, to improve financial planning and control and to provide a common data base as a reference in the analysis of acquisition and also of disinvestment decisions. In each company, the computer strategy objective has initiated a benchmark for limiting the search among alternative computer system plans.

It is apparent at this point that examples of other computer strategy objectives could be cited, drawn from different industrial contexts -- each derived from key corporate goals, with specific meaning in the context of a particular company. In the interests of brevity we will not elaborate further on these points. The principal question to be answered by company top management in establishing a computer strategy in each case is: What are the key corporate goals of the company? The listing and ranking of the company's

strategic goals lays the foundation for developing the company computer strategy objectives. Beyond objectives, top management must define the scope (policies) and establish the priorities (criteria) by which computer resources are rationed within the company.

IV. Summary and Conclusions

The management of computer systems today has become a key to corporate effectiveness in the total business environment. The intuitive or ad hoc approach to computer planning doesn't work. Effective utilization of the computer's potential demands that all levels of management participate in and contribute to the development of corporate computer systems.

Top management's responsibility in computer planning is the development of a company computer strategy which defines the computer's role in attaining the strategic objectives of the corporation. Formulation of a computer strategy involves decision making in three areas: establishing computer planning objectives on the basis of corporate goals; determining corporate policy for growth, resource commitment, and the management organization for computer systems; and appraising the company's current position in computer systems development. The company computer strategy provides a range of potential benefits (a threshold and a target performance level) for computer systems efforts. The computer executive and line management's responsibility is to develop a computer systems plan for implementing the company strategy. The computer systems plan is similar to other management plans of the company -- the financial plan, the marketing plan or the production plan. It provides the detailed action programs and resource allocations necessary to achieve a schedule of anticipated benefits -- that is, a timetable of future results. Lower management and operating personnel are responsible for the day-to-day implementation of this plan. The actual benefits realized over time provide the feedback through which the entire process is renewed.

The "computer revolution" of today is not slowing down and, if anything, will intensify in the future. The company top management who fails to recognize the _strategic_ potential of computer systems or who long delays in developing company computer resources, may discover too late this _sine qua non_ of future corporate success.

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13. ABSTRACT

The computer, formerly a determinant of the efficiency of internal corpora systems, is fast becoming a key to corporate effectiveness in the total business environment -- a major factor influencing corporate performance viz-a-viz competition.

To effectively capitalize on the true potential of corporate computer systems today, all levels of management must contribute and participate in their development. Too often the orphan of company computer system planning has been corporate top management, and the chief executive officer in particular. A fundamental requirement for the computer systems success is direction from the top. The form of this direction should be a company computer strategy: an explicit statement by top management of the computer's role in attaining the strategic objectives of the corporation.

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It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U)

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.